PO.DAAC MODIS LEVEL 3 DATA USER GUIDE

MODIS Dataset Version 2014.0

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Summary

Global Level 3 Mapped sea surface temperature (SST) products have been derived from the MODIS (MODerate Resolution Imaging Spectroradiometer) sensors onboard the NASA Terra (launched in 1999) and Aqua (launched in 2002) platforms by the NASA Ocean Biology Processing Group (O BPG). These SST products include MODIS Aqua and Terra mid-Infrared SST products which are derived from the 3 and 4 mid-IR bands (MODIS channels 20,21,22 and 23) and the thermal IR infrared (IR) SST products which are derived from the 11 and 12 um thermal IR infrared bands (MODIS channels 31 and 32). Both daytime and nighttime SST products are available for the thermal IR Infrared bands. Daily, weekly (8 day), monthly and annual MODIS SST products are available at both 4.63 and 9.26 km spatial resolution and for both daytime and nighttime passes.

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1 Introduction

This document is the Physical Oceanography Distributed Active Archive Center's (PO.DAAC) MODIS Sea Surface Temperature Level 4 v2014.0 data user's guide.

1.1 Purpose

The purpose of this user guide document is to provide researchers, students, and general users with a comprehensive guide to the MODIS Level 3 datasets provided by OBPG and archived on PODAAC system.

1.2 Overview of the Aqua and Terra Mission

MODIS (or Moderate Resolution Imaging Spectroradiometer) is a key instrument aboard the Terra AM) and Aqua satellites. Terra's orbit around the Earth is timed so that it passes from north to south across the equator in the morning, while Aqua passes south to north over the equator in the afternoon. Terra MODIS and Aqua MODIS are viewing the entire Earth's surface every 1 to 2 days, acquiring data in 36 spectral bands, or groups of wavelengths (see MODIS Technical Specifications). These data will improve our understanding of global dynamics and processes occurring on the land, in the oceans, and in the lower atmosphere. MODIS is playing a vital role in the development of validated, global, interactive Earth system models able to predict global change accurately enough to assist policy makers in making sound decisions concerning the protection of our environment.

1.2.1 Observed Parameter Definition

Sea Surface Temperature, Detail can be see MODIS Infrared Sea Surface Temperature Algorithm — Algorithm Theoretical Basis Document

1.2.2 Platform Orbit

Table 1 lists the details of Aqua and Terra satellite platforms and instrument characteristics.

Table 1. Satellite platform and instrument characteristics

Orbit	705 km, 10:30 a.m. descending node (Terra) or 1:30 p.m. ascending node (Aqua), sun-synchronous, near-polar, circular
Scan Rate	20.3 rpm, cross track
Swath Dimensions	2330 km (cross track) by 10 km (along track at nadir)
Telescope	17.78 cm diam. off-axis, afocal (collimated), with intermediate field stop
Size	1.0 x 1.6 x 1.0 m
Weight	228.7 kg
Power	162.5 W (single orbit average)
Data Rate	10.6 Mbps (peak daytime); 6.1 Mbps (orbital average)
Quantization	12 bits
Spatial Resolution	250 m (bands 1-2), 500 m (bands 3-7), 1000 m (bands 8-36) Design Life: 6 years

1.2.3 Instruments

Table 2 lists the details of MODIS spectral band characteristics.

Table 2. MODIS instrument spectral band characteristics

Primary Use	Band	Bandwidth[1]	Spectral Radiance[2]	Required SNR[3]
Land/Cloud/Aerosols Boundaries	1	620 - 670	21.8	128
	2	841 - 876	24.7	201
Land/Cloud/Aerosols Properties	3	459 - 479	35.3	243
	4	545 - 565	29.0	228
	5	1230 - 1250	5.4	74
	6	1628 - 1652	7.3	275
	7	2105 - 2155	1.0	110
Ocean Color/ Phytoplankton/ Biogeochemistry	8	405 - 420	44.9	880
	9	438 - 448	41.9	838
	10	483 - 493	32.1	802
	11	526 - 536	27.9	754
	12	546 - 556	21.0	750
	13	662 - 672	9.5	910
	14	673 - 683	8.7	1087
	15	743 - 753	10.2	586
	16	862 - 877	6.2	516
Atmospheric Water Vapor	17	890 - 920	10.0	167
	18	931 - 941	3.6	57
	19	915 - 965	15.0	250
Primary Use	**Band**	**Bandwidth[1]**	**Spectral Radiance[2]**	**Required NE[Δ]T(K)[4]**

Surface/Cloud Temperature	20	3.660 - 3.840	0.45(300K)	0.05
	21	3.929 - 3.989	2.38(335K)	2.00
	22	3.929 - 3.989	0.67(300K)	0.07
	23	4.020 - 4.080	0.79(300K)	0.07
Atmospheric Temperature	24	4.433 - 4.498	0.17(250K)	0.25
	25	4.482 - 4.549	0.59(275K)	0.25
Cirrus Clouds Water Vapor	26	1.360 - 1.390	6.00	150(SNR)
	27	6.535 - 6.895	1.16(240K)	0.25
	28	7.175 - 7.475	2.18(250K)	0.25
Cloud Properties	29	8.400 - 8.700	9.58(300K)	0.05
Ozone	30	9.580 - 9.880	3.69(250K)	0.25
Surface/Cloud Temperature	31	10.780 - 11.280	9.55(300K)	0.05
	32	11.770 - 12.270	8.94(300K)	0.05
Cloud Top Altitude	33	13.185 - 13.485	4.52(260K)	0.25
	34	13.485 - 13.785	3.76(250K)	0.25
	35	13.785 - 14.085	3.11(240K)	0.25
	36	14.085 - 14.385	2.08(220K)	0.35

1. Bands 1 to 19 are in nm; Bands 20 to 36 are in µm
2. Spectral Radiance values are (W/m^2 -µm-sr)
3. SNR = Signal-to-noise ratio
4. NE(Δ)T = Noise-equivalent temperature difference

Note: Performance goal is 30-40% better than required

1.2.4 Parameter Measurement Overview

Briefly, radiative transfer theory is used to correct for the effects of the atmosphere on the observations by utilizing "windows" of the electromagnetic spectrum where little or no atmospheric absorption occurs. Channel radiances are transformed (through the use of the Planck function) to units of temperature, then compared to a-priori (in situ) temperatures for algorithm development.

Adjustments to skin temperature are made through comparisons with in situ radiometer measurements.

1.2.5 Processing and Data Flows

The basic flow of data between components involved in the acquisition and processing of data for MODIS SST level 3 datasets are summarized below.

1.2.5.1 Processing Overview

NASA standard processing and distribution of the Sea Surface Temperature (SST) products from the MODIS sensors is now performed using software developed by the Ocean Biology Processing Group (OBPG). The OBPG generates Level-2 SST products using the Multi-Sensor Level-1 to Level-2 software (msl12), which is the same software used to generate MODIS ocean color products. The SST algorithm and quality assessment logic are the responsibility of the MODIS Science Team Leads for SST (currently P. Minnett and R. Evans of the Rosenstiel School of Marine and Atmospheric Science (RSMAS) at the University of Miami).

1.2.5.1.1 Short-wave (4µm) SST Algorithm

The Short-wave SST Algorithm makes use of MODIS bands 22 and 23 at 3.959 and 4.050 um. The brightness temperatures are derived from the observed radiances by inversion (in log spcae) of the radiance versus blackbody temperature relationship. For msl12, these relationships were precomputed for the spectral response of each MODIS channel, and the tables were then stored in HDF files to be loaded at run-time. In modsst, the radiance versus blackbody temperature relationship was computed at run-time. The algorithm for computing short-wave SST (sst4) from observed brightness temperatures is shown below.

1.2.5.1.1.1 Input:

- $BT39$: brightness temperature at 3.959 um, in deg C
- $BT40$: brightness temperature at 4.050 um, in deg C
- μ: cosine of sensor zenith angle

1.2.5.1.1.2 Output:

- SST in deg C

1.2.5.1.1.3 Generic Algorithm

- $dBT = BT39 - BT40$
- $sst4 = a0 + a1 \times BT39 + a2 \times dBT + a3 \times 1.0/\mu - 1.0$

Coefficients (MODIS only for now) $a0$, $a1$, $a2$, and $a3$ are derived and continuously verified by RSMAS based on match-ups between the satellite retrievals of brightness temperature and field measurements of sea surface temperature. As currently implemented, these coefficients can be time-dependent. The coefficients are provided to msl12 through external files, which are in a columnated ascii format of "sensor start-date end-date $a0$ $a1$ $a2$ $a3$".

The short-wave infrared bands near 4um are affected by bright reflective sources such as sun glint. Due to such contamination, the short-wave SST product is not considered valid for daytime use.

1.2.5.1.2 Long-wave (11μm) SST Algorithm

The long-wave SST algorithm makes use of MODIS bands 31 and 32 at 11 and 12 um. The brightness temperatures are derived from the observed radiances by inversion (in linear space) of the radiance versus blackbody temperature relationship. For msl12, these relationships were precomputed for the spectral response of each MODIS channel, and the tables were then stored in HDF files to be loaded at run-time. In modsst, the radiance versus blackbody temperature relationship was computed at run-time. The nonlinear SST algorithm was tuned for two different regimes based on brightness temperature difference. The algorithm for computing long-wave SST (sst) from observed brightness temperatures is shown below.

1.2.5.1.2.1 Input:

- $BT11$: brightness temperature at 11 um, in deg C
- $BT12$: brightness temperature at 12 um, in deg C
- $bsst$: baseline sst. At night the algorithm uses short-wave SST ($SST4$), where available. At daytime, the algorithm uses a reference SST source, operationally derived Reynolds Optimum Interpolation SST (OISST)
- μ: cosine of sensor zenith angle
- coefficients a_{ij},

The coefficients are derived and continuously verified by RSMAS based on match-ups between the satellite retrievals of brighness temperature and field measurements of sea surface temperature. As currently implemented, these coefficients can be time-dependent. The coefficients are provided to msl12 through external files, which are in a columnated asciiformat of "sensor start date end-date ai0 ai1 ai2 ai3", with each pair of lines corresponding to low and high dBT difference cases, respectively.

1.2.5.1.2.2 Output:

- SST in deg C

1.2.5.1.2.3 Generic Algorithm

- $dBT = BT11 - BT12$
- $dBT <= 0.5 \rightarrow sst = a00 + a01 \times BT11 + a02 \times dBT \times bsst + a03 \times dBT \times (1.0/\mu - 1.0)$
- $dBT >= 0.9 \rightarrow sst = a10 + a11 \times BT11 + a12 \times dBT \times bsst + a13 \times dBT \times (1.0/\mu - 1.0)$
- $0.5 < dBT < 0.9 \rightarrow$
  - $sstlo = a00 + a01 \times BT11 + a02 \times dBT \times bsst + a03 \times dBT \times (1.0/\mu - 1.0)$
  - $ssthi = a10 + a11 \times BT11 + a12 \times dBT \times bsst + a13 \times dBT \times (1.0/\mu - 1.0)$
  - $sst = sstlo + (dBT - 0.5)/(0.9 - 0.5) \times (ssthi - sstlo)$

Coefficients are sensor-dependent (only MODIS, for now).

1.2.5.2 Ancillary data for the SST products

The 11 and 4 micron window bands are used to derive the SST. A SST reference file is used as an aid in estimating the SST from the infrared band brightness temperature values. The reference file can be a climatology, a daily, preliminary SST estimate or a final estimate. Each data source does a trade-off between timeliness and quality.

- **SST Climatology Data**
  The SST climatology is a monthly climatology of the SST over the world.
  Parameters: Sea Surface Temperature (degrees C) average for each month of the year
  Source organization:JPL, NSIPP AVHRR Pathfinder, http://podaac-www.jpl.nasa.gov/ or http://podaac.jpl.nasa.gov/products/product112.html
  Spacial resolution: 4096 x 2049 lat, lon grid, about 9 km grid size (at equator)
  Temporal resolution: Grids for each month of the year
  Latency: None.
  Time covered: All time - a climatology
  Reference: http://podaac.jpl.nasa.gov/products/product112.html

- **SST Preliminary daily analysis data**
  The SST preliminary analysis is a daily file of SST derived from the AVHRR instrument as well as ship and buoy measurements. This SST, the satellite infrared window brightness temperatures, and coefficient files (latitude zone and month deliniated) are used to determine the SST.
  Parameters: Sea Surface Temperature (degrees C). Other included parameters are SST anomaly, SST Standard deviation estimated error, and Sea ice concentration
  Source organization:NOAA/National Climatic Data Center
  Spacial resolution: 720 x 1440 0.25 degree
  Temporal resolution: Daily
  Latency: 1 day (preliminary) 14 days (final, refined)
  Time covered: 1981 - current
  Reference: Reynolds et. al 2007: Daily High-resolution Blended Analyses Richard W. Reynolds, Thomas M. Smith, Chunying Liu, Dudley B. Chelton, Kenneth S. Casey, and Michael G. Schlax, 2007: Daily High-Resolution-Blended Analyses for Sea Surface Temperature. J. Climate, 20, 5473-5496. doi: http://dx.doi.org/10.1175/2007JCLI1824.1

- **SST Final Analysis data**
  The SST Final Analysis used more data and uses surrounding times to make a better estimate of the SST. The products produces are the same as the preliminary SST files (see above) but are available with a 14 day delay.

1.2.5.3 SST Quality Flags and Quality Level Definitions

A series of quality tests are performed for each sst or sst4 retrieval. The quality tests are used to set the quality levels, which are then used to control the Level-3 binning process. For the msl12 implementation, each quality test was assigned a bit in a product-specific flag array. A separate, 16-bit flag product was created for both the short-wave (sst4) and long-wave (sst) products (flags_sst4 and flags_sst, respectively). The 16 flag bits were assigned as follows:

Bit	Name	Description

00	ISMASKED	Pixel was already masked
01	BTBAD	Brightness temperatures are bad
02	BTRANGE	Brightness temperatures are out-of-range
03	BTDIFF	Brightness temperatures are too different
04	SSTRANGE	SST outside valid range
05	SSTREFDIFF	SST is too different from reference
06	SST4DIFF	Longwave SST is different from shortwave SST
07	SST4VDIFF	Longwave SST is very different from shortwave SST
08	BTNONUNIF	Brightness temperatures are spatially non-uniform
09	BTVNONUNIF	Brightness temperatures are very spatially non-uniform
10	BT4REFDIFF	Brightness temperatures differ from reference
11	REDNONUNIF	Red-band spatial non-uniformity or saturation
12	HISENZ	Sensor zenith angle high
13	VHISENZ	Sensor zenith angle very high
14	SSTREFVDIFF	SST is too different from reference
15	SST_CLOUD	Pixel failed the cloud decision tree

- ISMASKED
  Set if the SST processing is not performed because the pixel was masked prior to invocation. The msl12 code allows the user to specify a number of masking conditions. For standard SST processing, the only condition which would likely be selected for masking by msl12 at this stage is if the pixel is over land.

- BTBAD
  Set if the observed radiances are beyond the limits of the radiance to brightness temperature tables, such that brightness temperatures cannot be determined. This generally indicates saturation of one of the critical IR channels.

- BTRANGE
Set if one of the brightness temperatures falls outside the physically realistic range for ocean observations. The currently accepted range is −4 to 37 C. The 4μ band has a range of −4 to 35 C.

- BTDIFF
Set if the brightness temperature difference falls outside the physically realistic range for ocean observations. For long-wave SST, $dBT=BT11-BT12$ and the currently accepted range for dBT is 0 to 3.6 C. For short-wave SST, $dBT=BT39-BT40$ and the currently accepted range for dBT is 0 to 8 C.

- SSTRANGE
Set if the SST retrieval falls outside the physically realistic range for ocean observations. The currently accepted range is −2 to 40 C during the day and −2 to 37 C at night.

- SSTREFDIFF
Cold test. Set if SST–REFSST≥−3.0. This prevents flagging, as bad, good pixels that may be warmer than reference as a result of the diurnal heating of the skin surface at low wind speeds during the day. In regions likely to be contaminated by dust, where retrievals are generally colder, a more stringent cold threshold is applied; SST–REFSST≥−1.25. The *Dust Region* is defined as falling within a latitude ≤30N and >10S and longitude of and between 105E and 105W .
Cold tests are problematic in regions of high spatial variability (e.g., frontal boundaries), as the sstref field is very low in spatial resolution and smoothed over time.

- SST4DIFF
This test is only applicable at night. Set if the absolute difference between the long-wave and short-wave SST retrieval exceeds 0.8 C.

- SST4VDIFF
This test is only applicable at night. Set if the absolute difference between the long-wave and short-wave SST retrieval exceeds 1.0 C.

- BTNONUNIF
Set if one of the required brightness temperatures shows evidence of spatial non-uniformity. The uniformity is determined by examination of the 3×3-pixel area around the pixel of interest. If the difference between the maximum value and the minimum value in that 9-pixel set exceeds 0.7 C, the bit is set. This test does have a tendency to flag frontal boundaries and coastlines.

- BTVNONUNIF
Set if one of the required brightness temperatures shows a high degree of spatial non-uniformity. The test is identical to that of BTNONUNIF, but with a larger threshold. If the difference between the maximum value and the minimum value in the 9-pixel set exceeds 1.2 C the bit is set.

- BT4REFDIFF
This test is only valid at night. The test compares the brightness temperature difference ($dBT=BT39-BT40$) against a supplied reference temperature, where the reference is provided as a function of scan pixel (basis unknown by author). If the difference between dBT and $dBTref$ falls outside a specified range, the bit is set. The currently acceptable range is −1.1 to 10.0 C.

- REDNONUNIF
This test is only valid for daytime, and therefore only relevant to the long-wave SST product. Top-of-atmosphere reflectance, ρ_t, in the 678-nm band (MODIS band 14) is computed over the 3×3 pixel area centered on the pixel of interest, where

$$\rho_t = \frac{\pi \times L_t}{F_0 \times \mu_0 \times t \times t_0 \times t_{oz}}$$

and Lt is observed TOA radiance, F_0 is band-averaged solar irradiance (at day of year), μ_0 is cosine of solar zenith angle, t_0 and t are the diffuse transmittance through a Rayleigh atmosphere (solar path and sensor path), and t_{oz} is the ozone transmittance (inbound and outbound). If the difference between the maximum value and the minimum value of ρ_t in the 9-pixel set exceeds 0.01, the bit is set.
This bit is also set if 8 or more of the 9 pixels are saturated in the 678-nm band. In general, such saturation might indicate the presence of clouds, but it may also indicate the presence of sun glint. The long-wave SST is affected by clouds (SST retrieval appears colder than normal), but not by sun glint. To recover the sun glint case, the REDNONUNIF bit is only set if the retrieved SST is more than 1 C colder than the reference. This secondary requirement works best in locations with temporally and spatially stable SST conditions, where the low-resolution sstref and the retrieved SST can be expected to be consistent. The saturation test is a much more stringent test than the original uniformity test. The new test is can be summarized as: set if red band reflectance in the pixel neighborhood is saturated OR spatially nonuniform AND SST retrieval is cold relative to the reference.

- HISENZ
  Set if the sensor zenith angle exceeds 55 . For msl12, this is redundant with the HISATZEN bit in the *l2_flag* array, but with a different standard threshold.

- VHISENZ
  Set if the sensor zenith angle exceeds 75 . This is rare.

- SSTREFVDIFF
  Set to indicate that the difference between the retrieved SST and the reference is very large (5 C). The related flag, SSTREFDIFF, indicates that the difference between the retrieved SST and the reference is moderately large (3 C).

- SST_CLOUD
  Set if pixels fail either the day or night decision tree indicating a likely problem/contaminate in the atmosphere that may lead to failure of the SST atmospheric correction algorithm. Note that the SST_CLOUD flag is distinct from the OC_CLOUD flag.

The quality tests described above are used to set quality levels between 0 and 4, where 0 indicates best quality and 4 indicates complete failure or masked (usually land). The quality level determination varies between day and night conditions, and between the short-wave and long-wave SST products. The following tables show the quality test bits and associated quality levels. If no bits are set then the quality level is 0 but for short-wave SST retrievals in daylight the quality level is always set to 3 (bad) or 4 (failed or not computed). The quality level information for each SST product, sst and sst4, can be output by *msl12* as products *qual_sst* and *qual_sst4*, respectively.

Quality Bit	**Minimum Quality Level**			
	Daytime Long-Wave SST(1)	**Nighttime Long-Wave SST(2)**	**Daytime Short-Wave SST**	**Nighttime Short-Wave SST**
ISMASKED	4	4	4	4

BTBAD	4	4	4	4
VHISENZ	3	3		3
BTRANGE	3	3		3
SSTRANGE	3	3		3
BTVNONUNIF	3	3		3
SSTREFVDIFF	3	3		2
CLOUD	3	3		3
REDNONUNIF	2			
SSTREFDIFF	2	2		
BTNONUNIF	1	1		1
GLINT	1			
HISENZ	1	1		1
BT4REFDIFF		3		3
SST4VDIFF		2		2
SST4DIFF		1		1

(1) During the daytime if the SST reference <−1 K and red band reflectance is high, ρt>0.05 (where $\rho_t = \pi \times \frac{L_t}{F_0}$), the pixel quality is demoted one level.
(2) At night the SST quality is demoted one level if the shortwave BTNONUNIF is set.

1.2.5.4 Processing R2014.0 Improvements

The R2014.0 processing of MODIS Sea Surface Temperature (SST) data by the OBPG is the first major update to the MODIS SST algorithms in over a decade. The primary changes incorporated into this reprocessing were to the derivation and application of the correction factors for response versus scan angle (RVS) and mirror side. Algorithm coefficients are now latitude based. These changes, combined with minor adjustments to quality level definitions and thresholds for some SST flags, reduce the the global uncertainty of the SST product by ~0.1. In addition, seasonal and regional biases are reduced. Details are available in the white paper "Implementation of Version 6 AQUA and TERRA SST processing, K. Kilpatrick , G. Podesta, S. Walsh, R. Evans, P. Minnett".

1.2.5.4.1 Summary of Changes

1.2.5.4.1.1 Changes to the SST algorithms

- A total of 3 additional correction terms were added to both the LWIR SST and MWIR SST4 algorithm formulations; 2 terms are related to a satellite zenith angle correction and a single term relating to a mirror side correction
- Coefficients were estimated and are applied by latitude band and month of generic year.
    - The LWIR SST algorithm no longer selects coefficients based on brightness temperature difference as a proxy for water vapor.

1.2.5.4.1.2 Changes to SST Flag thresholds

- SSTREFDIFF changed to a cold only tests SST – REFSST >= -3.0 to prevent flagging, as bad, good pixels which may be warmer than reference as a result of the diurnal heating of the skin surface at low wind speeds during the day.
- SSTREFDIFF modified to include a more stringent cold threshold (SST – REFSST) >= -1.25, in regions likely to be contaminated by dust where retrievals are generally colder. Dust Region is defined as falling within a latitude <= 30N and > 10S and longitude of and between 105 E and 105W.
- SSTF CLOUD binary decision trees added to identify pixels with contaminated atmospheres (dust absorbing aerosols *etc*.) not captured by uniformity tests.

1.2.5.4.1.3 Quality level definition changes

- Quality 0 and Quality 1 definitions differ only by the SST Flag HISENZ and BTNONUNIF flag.
- Quality level of daytime pixels in glint regions, that are otherwise clear in all SST flags, can be no better than 1 due to visible band tests not being valid in the glint region
- Quality levels of pixels with the BTVNONUNIF set is changed to be no better than 3.
- Quality level of pixels with the SSTF CLOUD flag set can be no better than a 3. An inherited coding error was found in the version V5 code at OBPG, and traced to the original MODAPS code, whereby the SST CLOUD bit was being set but not evaluated in regard to the final quality level.
- Pixels failing the SSTREFDIFF are now assigned to Quality level 2
- Quality level 3 and better will be binned in global maps, previously only quality 2's and better were included.

1.2.5.5 Processing Frequency

The OBPG performs periodic reprocessings of the distributed data products from each supported mission when advances in algorithms or sensor calibration knowledge can be shown to significantly improve product quality or utility. These reprocessing events may span all missions (e.g., to incorporate refinements to common algorithms), or just one mission (e.g., to correct for error in sensor calibration).

1.2.5.6 Data Access

Archival of and access to all MODIS datasets is via the PO.DAAC
Brief summary of mode by which PODAAC acquires data from provider and/or cite ICD

1.3 Information Resources & Documentation

The present document focuses on format, access and usage aspects of the MODIS Level 3 data products for the current validated, v2014.0 release of the dataset. In this section, key information resources pertaining to MODIS Level 3 are provided together with a list of other important documentation on specific technical issues. Items listed are also referenced in related sections of this Guide as necessary.

1.3.1 User Support

PO.DAAC provides user support services for MODIS Level 3. Any questions regarding MODIS Level 3 data holdings, from how to access the data through questions on data format and usage, can be submitted via email to our user services team at: podaac@podaac.jpl.nasa.gov.

1.3.2 On-line Information Resources

General information on the MODIS Aqua/Terra mission and its current status is available from the project website. The following lists some useful website resources:

MODIS Page: http://modis.gsfc.nasa.gov/
Aqua Mission Page: http://aqua.nasa.gov/
Terra Mission Page: http://terra.nasa.gov/
OBPG Page: http://oceancolor.gsfc.nasa.gov/cms/
OBPG Document Page: http://oceancolor.gsfc.nasa.gov/cms/atbd/

1.3.3 MODIS Level 3 Technical Documentation

All key technical documents relating to MODIS are available from the PO.DAAC public FTP-site and listed below by category with links. The document producer is also specified. Items without hyperlinks and not on the FTP-site are in preparation.

Data Description Documents

- Ocean Level-3 Standard Mapped Image Products Specifications
- Data Format Specifications

Algorithm Description Documents

The Ocean Biology Processing Group (OBPG) produces and distributes a standard suite of sea surface temperature products for MODIS at Level-2 and Level-3. The sea surface temperature are derived from long-wave (11-12 µm) thermal radiation and short-wave (3-4 µm) thermal radiation separately. The MODIS data are available in a variety of spatial resolutions and temporal periods. The Level 3 mapped products are global gridded data sets with all points filled even over land. The Level 3 mapped files are derived from the Level 3 binned files. The descriptions and references for these standard products are provided below:

- 11 µm Sea Surface Temperature (SST; ºC)
- 4 µm Sea Surface Temperature (SST4; ºC)

Instrument Calibration (post-launch) Documents

- Specifications:

  For the IR channels onboard calibration consists of a v-groove Blackbody as well as a view to space. Additional onboard calibrators consist of a Solar Diffuser, a Spectroradiometric calibration assembly and a Solar Diffuser Stability Monitor.
- Tolerance:

The noise equivalent temperature difference (NET) for the IR channels are:

MODIS Channel	Bandwidth (um)	NET (deg K)
20	3.66-3.84	0.05
22	3.929-3.989	0.07
23	4.02-4.08	0.07
31	10.78-11.28	0.05
32	11.77-12.27	0.05

- Frequency of Calibration:
  A blackbody measurement is taken for each scan.

MODIS Level 3 Validation Documents

- Validation information : Marine Optical Buoy (MOBY)

2 MODIS Level 3 Data Discovery & Access

This section describes how users can search for MODIS Level 3 data products via the PO.DAAC website portal and then access the data via available tools and services. MODIS data archived at PO.DAAC include Level-2, and Level-3 products (see section 3 for details). Please note though that only L2 and L3 MODIS data are supported.

2.1 Search

The PO.DAAC portal supports interactive, drill-down searches and exposure of our data product catalogues by measurement parameter, sensor, satellite platform, collection or keyword. Simply entering the keyword “MODIS Level 3 v2014.0” in the dataset search bar on the main portal page returns a list of all MODIS L3 datasets maintained within the PO.DAAC archive with associated metadata descriptions.

2.2 Data Access via FTP and Site Organization

All MODIS Level 3 validated data (version 2014.0 and above) and related resources are accessible via the public PO.DAAC FTP-site (ftp://podaac-ftp.jpl.nasa.gov/allData/modis/L3/). The contents and organization of the Aquarius portion of this site is described below. *

2.2.1 ReadMe Files

Each root level of MODIS L3 data folder contains a ReadMe file that summarises some information provided here and in other sections of this User’s Guide. *README* describes the site layout. Information documenting current known issues with the MODIS L3 dataset is available in the text file *README.KnownIssues. README.EventLog* describes the source, location and contents of available MODIS L3 Event log information. While much of this information is also captured in this Guide, users should periodically consult the READMEs for the most up to date information on these aspects. Information in the README files are dataset version independent.

2.2.2 Data Directories

MODIS L3 data on the FTP-site range from different spectral band, spatial resolution, daily, 8 day average, monthly average and annual average are organized according to the pattern summarized in table 3.

Table 3. PO.DAAC FTP-site Organization for MODIS Level 3 Data Product

MODIS Data Type	Satellite Platform	Spectra Band	Spatial Resolution	Time Period	Day/Night	Access URL prepend with ftp://podaac-ftp.jpl.nasa.gov/allData/modis/L3/
Level-3	Aqua Satellite	4um (IR)	4km	daily		aqua/4um/<version>/4km/daily/<*YYYY*>/<*DDD*>
				8day		aqua/4um/<version>/4km/8day/<*YYYY*>/
				monthly		aqua/4um/<version>/4km/monthly/<*YYYY*>/
				annual		aqua/4um/<version>/4km/annual/<*YYYY*>/
			9km	daily		aqua/4um/<version>/9km/daily/<*YYYY*>/<*DDD*>
				8day		aqua/4um/<version>/9km/8day/<*YYYY*>/
				monthly		aqua/4um/<version>/9km/monthly/<*YYYY*>/
				annual		aqua/4um/<version>/9km/annual/<*YYYY*>/

		11um (Thermal-IR)	4km	Daily	Day	aqua/11um/<version>/4km/daily/<YYYY>/<DDD>
					Night	aqua/11um/<version>/4km/daily/<YYYY>/<DDD>
				8day	Day	aqua/11um/<version>/4km/8day/<YYYY>/
					Night	aqua/11um/<version>/4km/8day/<YYYY>/
				monthly	Day	aqua/11um/<version>/4km/monthly/<YYYY>/
					Night	aqua/11um/<version>/4km/monthly/<YYYY>/
				annual	Day	aqua/11um/<version>/4km/annual/<YYYY>/
					Night	aqua/11um/<version>/4km/annual/<YYYY>/
			9km	daily	Day	aqua/11um/<version>/9km/daily/<YYYY>/<DDD>
					Night	aqua/11um/<version>/9km/daily/<YYYY>/<DDD>
				8day	Day	aqua/11um/<version>/9km/8day/<YYYY>/
					Night	aqua/11um/<version>/9km/8day/<YYYY>/
				monthly	Day	aqua/11um/<version>/9km/monthly/<YYYY>/
					Night	aqua/11um/<version>/9km/monthly/<YYYY>/
				annual	Day	aqua/11um/<version>/9km/annual/<YYYY>/
					Night	aqua/11um/<version>/9km/annual/<YYYY>/
	Terra Satellite	4um (IR)	4km	daily		terra/4um/<version>/4km/daily/<YYYY>/<DDD>
				8day		terra /4um/<version>/4km/8day/<YYYY>/
				monthly		terra /4um/<version>/4km/monthly/<YYYY>/
				annual		terra /4um/<version>/4km/annual/<YYYY>/
			9km	daily		terra /4um/<version>/9km/daily/<YYYY>/<DDD>
				8day		terra /4um/<version>/9km/8day/<YYYY>/
				monthly		terra /4um/<version>/9km/monthly/<YYYY>/
				annual		terra /4um/<version>/9km/annual/<YYYY>/
		11um (Thermal-IR)	4km	daily	Day	terra /11um/<version>/4km/daily/<YYYY>/<DDD>
					Night	terra /11um/<version>/4km/daily/<YYYY>/<DDD>
				8day	Day	terra /11um/<version>/4km/8day/<YYYY>/
					Night	terra /11um/<version>/4km/8day/<YYYY>/
				monthly	Day	terra /11um/<version>/4km/monthly/<YYYY>/
					Night	terra /11um/<version>/4km/monthly/<YYYY>/
				annual	Day	terra /11um/<version>/4km/annual/<YYYY>/
					Night	terra /11um/<version>/4km/annual/<YYYY>/
			9km	daily	Day	terra /11um/<version>/9km/daily/<YYYY>/<DDD>
					Night	terra /11um/<version>/9km/daily/<YYYY>/<DDD>
				8day	Day	terra /11um/<version>/9km/8day/<YYYY>/
					Night	terra /11um/<version>/9km/8day/<YYYY>/
				monthly	Day	terra /11um/<version>/9km/monthly/<YYYY>/
					Night	terra /11um/<version>/9km/monthly/<YYYY>/
				annual	Day	terra /11um/<version>/9km/annual/<YYYY>/
					Night	terra /11um/<version>/9km/annual/<YYYY>/

Where:
<YYYY> is the Year e.g. 2013 (applies to all product levels)
<DDD> is the Julian Day of year e.g. 312 (applies to product levels 3)
<version> is the version of the Aquarius dataset e.g. v2.0 (applies to all product levels 3)

2.2.3 Documentation Directory

The FTP-site ftp://podaac-ftp.jpl.nasa.gov/allData/modis/L3/ root level subdirectory /***docs*** contains the User's Guide to the MODIS L3 data together with other key documents on specific technical aspects provided by the OBPG Science Team. A listing of available items was given in section 1.3.3 above. Since this documentation is data version dependent, users should consult available documents and associated version directory corresponding to the dataset version they are using (e.g. /***docs/v2014.0*** *).*

2.2.4 Reader Software Directory

The FTP-site ftp://podaac.jpl.nasa.gov/allData/ghrsst/sw/generic_nc_readers/ root level subdirectory ***/generic_nc_readers*** contains software written in MATLAB, IDL and Python that can be used to read the netcdf 4 data. A later section (2.4.5) describes the usage of these routines. Reader software provided will work for all versions of the MODIS L3 data.

2.3 Data Access via Web-services

All MODIS L3 datasets are additional available via OPenDAP and THREDDS Web-services from PO.DAAC.

2.3.1 OPeNDAP

OPenDAP is a data transport architecture and HTTP-based protocol widely used by the earth science community and supported by PO.DAAC. It allows both interactive person-to-machine and automated machine-to-machine access to data, with optional additional data sub-setting options specified by an extended URL. The structure of the basic URL for accessing MODIS L3 datasets is as follows and analogous to that previously described for FTP:

http://opendap.jpl.nasa.gov/opendap/OceanTemperature/modis/

2.3.2 THREDDS

Aquarius data are also accessible from PO.DAAC via THREDDS (Thematic Realtime Environmental Distributed Data Services), a framework for dynamic distributed aggregation, cataloging and publication of datasets, metadata and associated resources via the Internet. The THREDDS catalogue at PO.DAAC for Aquarius can be accessed by users via the following URL:

http://thredds.jpl.nasa.gov/thredds/podaac_catalogs/MODIS_L3_SMI_V2014_catalog.html

Complete L3 daily, 7day, monthly, and seasonal time series for both salinity and wind speed respectively are aggregated and accessible via THREDDS. For each THREDDS aggregation, access is available via a range of protocols including OPeNDAP, WCS, WMS, some of which permit interactive subsetting by parameters such as time. Dynamic plotting options are also available for selected data series and subsets via THREDDS.

2.4 Data Access via Tools

List project and PO.DAAC tools implemented with some descriptions and maybe even illustrative figures. These are summarized briefly here and access links are provided.

2.4.1 Reader Software

Users simply wanting to browse the structure, metadata and data contents of MODIS data files interactively via a GUI tool should consider the following free and easy to use software packages: Panoply (NASA/GISS) and HDFview (HDFgroup). For users wanting to access MODIS data for analysis, PO.DAAC provides routines in MATLAB, IDL and Python in the \SW directory of the FTP-site to read the MODIS L2 and L3 netcdf4 data files. This section briefly describes the usage of these routines. Basic familiarity with the MATLAB, IDL and Python scientific programming environments is assumed.

2.4.1.1 MATLAB Reader

- read_nc_file_struct.m
    - This file contains one Matlab program that is a high level NetCDF reader. It will read any NetCDF file. If the file is properly formatted, CF or another standard format, it will apply offsets and scaling automatically and will replace the fill values with NaNs. Otherwise you will need to do this manually. This program will output all of the variables in the file into a structure.

      INPUTS:
      Full path of the NetCDF filename

      RETURNS:
        - finfo = File information, as a structure, with the Global and Variable Attributes
        - outstrct = structure containing all of the variables within the specified file. The first field in the structure is the filename
        - This function will output Variable and Global Attributes to the screen.

      USAGE:
      >> [finfo outstrct] = read_nc_file_struct('filename');

- modis_example.m
    - This file contains one Matlab example program that uses the high level NetCDF reader read_nc_file_struct.m by using MODIS Level 3 sample file A20151372015144.L3m_8D_NSST_sst_4km.nc which is in the same directory. The program will output all of the variables in the file into a structure and display to the terminal.

      USAGE:
      >> modis_example

2.4.1.2 IDL Reader

- get_netcdf_global_atts.pro
    - This file contains one IDL subroutine that is a high level NetCDF reader. It will read all netCDF global attributes into an anonymous structure. Anonymous structures are required for reading multiple netCDF files that have different global attributes.

      INPUTS:
        - ncdf_id: the file ID returned by the ncdf_open IDL command that opens a netCDF file for reading (remember to close it).

      RETURNS:
      An anonymous structure with all netCDF global attributes.

      USAGE:
      IDL> ncdf_id = ncdf_open('myNetCDF.nc', /nowrite)
      IDL> global_struct = get_netcdf_global_atts(ncdf_id)
      IDL> ncdf_close, ncdf_id
      IDL> help, global_struct

- get_netcdf_vars.pro

- This file contains one IDL subroutine that is a high level NetCDF reader. It will read all netCDF variables and their attributes into a set of anonymous structures. Anonymous structures are required for reading multiple netCDF files that have different variables and attributes.

  INPUTS:
  - ncdf_id: the file ID returned by the ncdf_open IDL command that opens a netCDF file for reading (remember to close it)

  RETURNS:
  an anonymous structure containing all variables and their attributes (as additional anonymous structures)

  USAGE:
  IDL> ncdf_id = ncdf_open('myNetCDF.nc', /nowrite)
  IDL> ncdf_struct = get_netcdf_vars(ncdf_id)
  IDL> ncdf_close, ncdf_id
  IDL> help, ncdf_struct

- ncwrapper.pro
  - This file contains one IDL sample file that shows how to use the IDL reader routines get_netcdf_vars.pro, get_netcdf_global_atts.pro to read all netCDF variables and their attributes and output to the terminal.

    INPUTS:
    NetCDF filename

    USAGE:
    IDL> ncwrapper, 'netCDF_file.nc'

2.4.1.3 Python Reader

- readnc.py
  - This file contains the Python NetCDF reader module that contains two functions readGlobalAttrs and readVars. These functions are the high level NetCDF reader. They will read all netCDF variables, variable attributes and global attributes into a list of structures.

- ncwrapper.py
  - This file contains one Python sample file that shows how to use the Python reader module readnc.py to read all netCDF variables and their attributes and output to the terminal.

    INPUTS:
    NetCDF filename

    USAGE:
    % python ./ncwrapper.py -f <filename>
    ... or ...
    % ./ncwrapper.py -f <filename>

2.4.1.4 R Reader

- funcReadNcdf.r
  - This file contains the R program NetCDF reader that is a high level NetCDF reader. It reads any generic, user defined NetCDF "Classic" file and returns a series of data

structures that capture in memory and potentially expose all attributes, variables, and data values.

INPUTS:
- fpath: specifies the working directory where the source NetCDF file is located
- fname: file name of source NetCDF data file
- printFlag: if set to TRUE, list NetCDF file summary information on screen (Default setting = FALSE)

RETURNS:
- nDims, nGatts,nVars: number of Dimensions, Global Attributes, Variables respectively
- Dims, gAtts, VarAtts: structure arrays with respective dimensional, global and variable attributes with associated values
- Var.Data: structure array containing the data values for all variables by variable element
- optional - print listing of key file information to screean (if printFlag = TRUE)

USAGE:
Call the "ReadNcdf() " function from either the R command line or from within a script using suitable arguement values

- CallFunc_ReadNcdf.r
  - This file contains the R program sample file that shows how to use the R reader ReadNcdf to read all netCDF variables and their attributes. All file metadata and data elements are read into memory arrays for access. Illustrations of how to access the range of data structures are provided.

    INPUTS:
    - fpath: specifies the working directory where the source NetCDF file is located
    - fname: file name of source NetCDF data file
    - printFlag: if set to TRUE, list NetCDF file summary information on screen (Default setting = FALSE)
    - nOutputElements: number of data array (VarData) elements to output per data variable (eg. 10)
    - nOutputRows: number of data rows output to screen before pause and user prompt (eg. 20)

    USAGE:
    The script automatically invokes the ReadNcdf function to capture and expose attributes and data of the user-selected .nc file.

    OUTPUTS
    - all NetCDF file elements read into R data structures in memory for usage
    - dimAtts, gAtts, carAtts: structure arrays with respective dimensional, global and variable attributes with associated values
    - varData: structure array containing the data values for all variables by variable element
    - optional (if printFlag = TRUE)
      - print listing of all global file and variable attributes to screen with associated values
      - print sample data for each data variable (number elements output per variable = nOutputElements)

3 MODIS Level 3 Data Products

3.1 Level-3 mapped Products

Level-3 standard mapped image (SMI) products depict sea surface temperature. L3 mapped SST products are generated for the same spatial and temporal resolutions. Each file has a spatial resolution of 1 degree, and values represent averages for grid cells over predefined temporal intervals. Daily, 7 day, monthly, seasonal (3 months) and annual products are available. …

3.2 File Naming Conventions

All times and dates are to be in Coordinated Universal Time (UTC).

The MODIS file naming convention as applied to specific product levels is shown in the following table 4.

Table 4. MODIS Data File Naming Conventions by product level

MODIS Data Level-3	Time Period	File Naming Convention
Level 3 Standard Mapped Image	Daily	**[Platform][yyyy][ddd].L3m_[period]_[N]SST_sst_[stype].nc** **Platform** indicates satellite platform with A for Aqua and T for Terra **stype** will either be 4km or 9km indicating the spatial resolution. **Period** indicates that the temporal resolution, DAY for daily, 8D for 8 day, MO for monthly and YR for annual. **N** indicates night data only Examples: A2010340.L3m_DAY_SST_sst_4km.nc A2010340.L3m_DAY_NSST_sst_4km.nc
	Non-Daily	**[Platform][yyyy][ddd][yyyy][ddd].L3m_[period]_[N]SST_sst_[stype]** **Platform** indicates satellite platform with A for Aqua and T for Terra **stype** will either be 4km or 9km indicating the spatial resolution. **Period** indicates that the temporal resolution, DAY for daily, 8D for 8 day, MO for monthly and YR for annual. **N** indicates night data only Examples: A20103452010352.L3m_8D_SST_sst_4km.nc A2010340.L3m_8D_NSST_sst_4km.nc

4 MODIS Level 3 Data Product Structure

4.1 Data Format

All MODIS data files are in NetCDF-4 format. NetCDF (network Common Data Form) is a data model for array-oriented scientific data, as well as a freely distributed collection of access libraries that support implementation of the same data model, and a machine-independent data format. Together, the interfaces, libraries, and format support the creation, access, and sharing of scientific data. NetCDF-4, which is based on HDF5 (versions 1.8 and later) was introduced in 2008. NetCDF-4 Classic, also introduced in 2008 combines the simpler data model of netCDF-3 with the HDF5-based storage capabilities of netCDF-4.

NetCDF-4 format files offer new features such as groups, compound types, variable length arrays, new unsigned integer types, parallel I/O access, etc. None of these new features can be used with classic or 64-bit offset files.

With netCDF-4 format, the zlib library can provide compression on a per-variable basis. That is, some variables may be compressed, others not. In this case the compression and decompression of data happen transparently to the user, and the data may be stored, read, and written compressed.

4.2 Level-3 File Organization & Description

MODIS Level-3 SST data products are provided in NETCDF4 file format. Each file contains a global level metadata portion, data array of type 32-bit float sst for 11um measurement and sst4 for 4um measurement contains the geo-referenced measurement values in units of Kelvin along with the add_offset and scale_factor attributes. Additionally, a data structure with color palette information (***palette***: 3x256 of type Byte) is also present in the L3 files. The positional index for a given cell value within the 2-dimensional data array corresponds to the Longitude and Latitude of the MODIS SST observation. All of the MODIS SST product files have identical data and metadata structures except the array size for different spatial resolutions such as 4.6 km and 9.2 km. The filenames for these products conforms to standards previously described and illustrated by the following examples:

A2010340.L3m_DAY_SST_sst_4km.nc (MODIS Aqua Daily SST)
T2010340.L3m_DAY_SST_sst_4km.nc (MODIS Terra Daily SST)
A2010340.L3m_DAY_SST_sst_4km.nc (MODIS Aqua Daily SST)
T2010340.L3m_DAY_SST_sst_4km.nc (MODIS Terra Daily SST)
A20151932015200.L3m_8_SST_sst_4km.nc (MODIS Aqua 8 Day SST)
T20151932015200.L3m_8_SST_sst_4km.nc (MODIS Terra 8 Day SST)

4.2.1 Level-3 Sea Surface Temperature Standard Mapped Image File Structure

This section describes the L3m standard mapped image (SMI) SST product line and the attributes of the file-level metadata in particular since otherwise the organization of the data variables themselves is identical. Table 5 lists global metadata attributes with representative values for L3m SST products.

Table 5. MODIS Level-3 Mapped SST Product Global Metadata Attributes by Category.

Attribute Name	Description/Value	Type	Array Size
	MISSON and DOCUMENTION ATTRIBUTES		
Product Name	The name of the product file (without path). E.g. T20151932015200.L3m_8_SST_sst_4km.nc	String	Scalar
Software Version	Identifies version of the software used to create this product. (e.g. 5.04)	String	Scalar
Software Name	Identifies name of the software used to create this product. (e.g. smigen)	String	Scalar
Processing Version	Identifies the version of the products (e.g. V2014.0)	String	Scalar
Processing Time	Local time of generation of this product; concatenated digits for year, day-of-year, hours, minutes, seconds, and fraction of seconds in the format of YYYY-MM-DDTHH.MM.SS.000Z. (e.g. 2015-08-05T11:20:19.000Z)	String	Scalar
Sensor Name	MODIS	String	Scalar
Platform	Aqua or Terra	String	Scalar
Conventions	CF-1.6	String	Scalar
Start orbit Number		Integer (32-bit)	Scalar
End orbit Number		Integer (32-bit)	Scalar
L2 Flag Names	Level-2 product flags that were used to mask data samples; same as for parent Level-3 binned product	String	Scalar
	DATE/TIME ATTRIBUTES		
Temporal Range	"day", "8-day", "month", or "year"; represents product time period	String	Scalar
Start Time	Start UTC of the first block of the orbit; concatenated digits for year, day-of-year, hours, minutes, seconds, and fraction of seconds in the format of YYYY-MM-DDTHH.MM.SS.000Z. e.g.2015-07-18T23:45:10.000Z	String	Scalar
End Time	Start UTC of the last block of the orbit; concatenated digits for year, day-of-year, hours, minutes, seconds, and fraction of seconds in the format of YYYY-MM-DDTHH.MM.SS.000Z. e.g.2015-07-18T23:45:10.000Z	String	Scalar
	SCENE COORDINATES		
Map Projection	Equidistant Cylindrical	String	Scalar
Northernmost Latitude	90.0 for standard products	Float (32-bit)	Scalar
Southernmost Latitude	-90.0 for standard products	Float (32-bit)	Scalar
Westernmost Latitude	-180.0 for standard products	Float (32-bit)	Scalar
Easternmost Latitude	180.0 for standard products	Float (32-bit)	Scalar
Latitude Step	latitudinal distance between lines (180./Number of Lines)	Float (32-bit)	Scalar
Longitude Step	longitudinal distance between columns (360./Number of Columns)	Float (32-bit)	Scalar
	DATA DESCRIPTION		
Data Bins	number of bins containing data in the parent binned product	Integer (32-bit)	Scalar
Number of Lines	number of points in the vertical (longitudinal) direction	Integer (32-bit)	Scalar
Number of Columns	number of points in the horizontal (latitudinal) direction	Integer (32-bit)	Scalar
Measure	"Mean"; statistical method used to compute values for grid points	Integer (32-bit)	Scalar
Data Minimum	minimum value of the input data used to generate	Float (32-bit)	Scalar
Data Maximum	maximum value of the input data used to generate	Float (32-bit)	Scalar
Suggested Image Scaling Minimum	suggested minimum value of l3m_data to be used for display as an image	Float (32-bit)	Scalar
Suggested Image Scaling Maximum	suggested maximum value of l3m_data to be used for display as an image	Float (32-bit)	Scalar
Suggested Image Scaling Type	"LINEAR" or "LOG"; suggested function to be used to scale l3m_data for display as an image	Float (32-bit)	Scalar
Suggested Image Scaling Applied	"Yes" or "No"; indicates whether suggested scaling has already been applied to l3m_data; for 1-byte or 2-byte data types	Float (32-bit)	Scalar
	DATA ARRAYS		

Attribute Name	Description/Value	Type	Array Size
sst	array size Number of Lines x Number of Columns), array of SST data for 11um; may be converted into real values using attributes Base, Slope, and Intercept as described by attributes Scaling and Scaling Equation. The value indicated by the attribute Fill is reserved to indicate "no data"; i.e., a bin for this geographic location does not exist in the parent Level-3 binned product.	Float (32-bit)	2D Array
sst4	array size Number of Lines x Number of Columns), array of SST data for 4um; may be converted into real values using attributes Base, Slope, and Intercept as described by attributes Scaling and Scaling Equation. The value indicated by the attribute Fill is reserved to indicate "no data"; i.e., a bin for this geographic location does not exist in the parent Level-3 binned product.	Float (32-bit)	2D Array
qual_sst	array size Number of Lines x Number of Columns), quality levels associated with SST data for 11um; values of 0 represent best quality, and quality decreases with increasing values	Integer (32-bit)	2D Array
qual_sst4	array size Number of Lines x Number of Columns), quality levels associated with SST data for 4um; values of 0 represent best quality, and quality decreases with increasing values	Integer (32-bit)	2D Array

5 MODIS Data Accuracy and Validation

The SST algorithm and quality assessment logic are the responsibility of the MODIS Science Team Leads for SST (currently P. Minnett and R. Evans of the Rosenstiel School of Marine and Atmospheric Science (RSMAS) at the University of Miami). Users are urged to read the MODIS data validation analysis document carefully to understand the accuracy limits and warnings about when and where residual errors could be misinterpreted as oceanographic signals, particularly in certain regions and on certain time scales.

6 References

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